

CONTRIBUTIONS
FROM THE
CUSHMAN LABORATORY
FOR
FORAMINIFERAL RESEARCH

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CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

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These contributions will be issued quarterly. They will contain short papers with plates, describing new forms and other interesting notes on the general research work on the foraminifera being done on the group by the workers in this laboratory. New literature as it comes to hand will be briefly reviewed.

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CONTRIBUTIONS FROM THE CUSHMAN LABORATORY FOR FORAMINIFERAL RESEARCH

160. SOME NEW FORAMINIFERA FROM THE LATE TERTIARY OF GEORGES BANK

By JOSEPH A. CUSHMAN

The species of foraminifera here described were obtained from the walls of the deep canyons cut in the southward side off Georges Bank off the New England coast. A full account of the localities and the relationships of these samples will be found in a forthcoming paper describing more fully the foraminifera of both the Cretaceous and Tertiary samples of these localities. Charts showing the relationships of the canyons and the tows will also be found in the paper referred to. From what is known of the other elements of the fauna, it is to be expected that these new forms may later be found living in either this same region or, in the case of the Greensand samples, farther south along the Atlantic coast, or in the general West Indian region.

LISTERELLA NODULOSA (Cushman), var. *GLABRATA* Cushman, n. var. (Pl. 12, fig. 1)

Variety differing from the typical in the smaller size, more slender form, and the very smoothly finished, polished surface.

Holotype of variety (Cushman Coll. No. 22234) from Green clay, Canyon III, Tow 9, Georges Bank.

This variety which occurs with the typical is very distinctive in our material.

MARGINULINA GEORGIANA Cushman, n. sp. (Pl. 12, figs. 2, 3)

Test elongate, early portion close coiled, somewhat conspicuously keeled, later uncoiled portion consisting of 4 or 5 chambers becoming more inflated, nearly circular in transverse section or lacking the keel of the early portion; chambers somewhat inflated, fairly distinctive, particularly in the later uncoiled portion, considerably overlapping; sutures fairly distinct, particu-

larly in the later uniserial portion where they are distinctly depressed, earlier ones nearly radiate, somewhat curved in the earlier portion, later becoming oblique, and in the adult portion at right angles to the axis; wall smooth, thick; aperture radiate, with distinct, projecting tooth-like processes, terminal, at the dorsal margin. Length up to 1.75 mm.; breadth 0.85 mm.; thickness 0.50 mm.

Holotype (Cushman Coll. No. 22235) from Greensand, Canyon III, Tow 9, Georges Bank.

This is a distinctive species reminding one somewhat of *Marginulina bacheii* Bailey, but is not as large a species and has a very distinct keel in the earlier portion.

GUTTULINA GEORGIANA Cushman, n. sp. (Pl. 12, figs. 4 a, b)

Test generally ovate, somewhat compressed, initial end pointed, with a distinct spinose process, apertural end somewhat extended, periphery broadly rounded; chambers fairly distinct, earlier somewhat sigmoid, later ones tending to become somewhat biserial, inflated; sutures fairly distinct, very slightly depressed except in the later portion, oblique curve; wall thick, smooth; aperture terminal, ovate with distinct teeth at the border. Length 1.40 mm.; breadth 0.85 mm.; thickness 0.50 mm.

Holotype (Cushman Coll. No. 22239) Greensand, Canyon III, Tow 9, Georges Bank.

This new species is unlike any of the other Recent or Tertiary ones from this general region.

GLANDULINA BASI-SPINATA Cushman, n. sp. (Pl. 12, figs. 6-8)

Test fusiform in front view, with the greatest breadth either below or above the middle, circular in transverse section; chambers in the early portion biserial, later uniserial, and strongly overlapping; sutures fairly distinct, mostly marked by a series of short acicular spines, often in a distinct group at the initial end, as well as over the sutures; walls otherwise smooth; aperture terminal, radiate, the radiating teeth occasionally becoming spinose and projecting. Length 0.80-0.90 mm.; diameter 0.60-0.70 mm.

Holotype (Cushman Coll. No. 22237) from Green clay, Canyon II, Tow 6.

This is a very distinctive species with its peculiar spinose projections over the sutures.

ELPHIDIUM GEORGIANUM Cushman, n. sp. (Pl. 12, figs. 5 a, b)

Test close coiled throughout, completely involute, strongly umbonate, periphery subacute, slightly lobulate; chambers fairly distinct, about 12 in the last-formed coil, the later ones very slightly inflated; sutures fairly distinct, covered, particularly toward the periphery, with about 10 retral processes in the adult; walls fairly thick, distinctly perforate; aperture consisting of a series of small pores at the base of the apertural face. Diameter 0.70 mm.; thickness 0.30 mm.

Holotype (Cushman Coll. No. 22240) from Green clay, Canyon III, Tow 9, Georges Bank.

This species occurs rather commonly in the Late Tertiary and in the cores that were taken in this general region. It has not been found as a Recent form, but probably will be in this same general region.

PLECTOFRONDICULARIA BASI-SPINATA Cushman, n. sp. (Pl. 12, figs. 11 a, b)

Test elongate, tapering from the somewhat blunt, slightly spinose initial end with the greatest breadth near the base of the last-formed chamber, much compressed, sharply keeled throughout; chambers distinct, earliest ones slightly biserial, the others uniserial, increasing rather regularly in size and height as added; sutures strongly limbate, later ones distinctly depressed; wall smooth except at the initial end which has a few short, stout costae covering only the proloculum and immediately succeeding chambers, projecting at the base into short spines; aperture terminal, very broadly elliptical with short neck and thickened lip. Length 2.00 mm.; breadth 0.60 mm.; thickness 0.15 mm.

Holotype (Cushman Coll. No. 22243) Green clay, Canyon II, Tow 6, Georges Bank.

PLECTOFRONDICULARIA GEORGIANA Cushman, n. sp. (Pl. 12, figs. 13 a, b)

Test elongate, tapering from the acute initial end to the greatest breadth formed by the final chamber, much compressed, periphery acute and keeled; chambers distinct except the earliest which are biserial and somewhat obscured by the ornamentation of the surface, followed by uniserial ones increasing rather regularly in height and size as added, later ones slightly inflated; sutures fairly distinct, limbate, the later ones slightly depressed; wall for the most part smooth except for the earlier portion which has numerous longitudinal costae, strongest near the initial end

thence becoming obsolescent at about the middle of the adult chamber; aperture terminal broadly elliptical with a trace of teeth about the margin. Length 2.20 mm.; breadth 0.60 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 22241) from Green clay, Canyon II, Tow 6, Georges Bank.

This species differs from *P. angusti-costata* in the shape of the test, which in *P. angusti-costata* has the sides nearly parallel, while in *P. georgiana* they increase in size throughout. From *P. basi-spinata* it differs in the earlier portion, which in the latter species has a few distinct costae ending in a bluntly pointing test with distinct basal spines.

PLECTOFRONDICULARIA ANGUSTI-COSTATA Cushman, n. sp. (Pl. 12, figs. 12 a, b)

Test elongate, the earlier portion tapering from the subacute initial end, the adult with the sides nearly parallel, much compressed, more so toward the apertural end, periphery subacute, not keeled; chambers of the earliest portion biserial, adult portion uniserial, chambers rather indistinct, those of the earliest part largely obscured by the ornamentation; sutures obscure except the later ones which are slightly depressed and strongly limbate; walls of the earlier portion with numerous distinct, longitudinal costae becoming obsolescent near the middle of the test; aperture broadly elliptical, small, rather distinct neck and thickened lip. Length 1.50 mm.; breadth 0.30 mm.; thickness 0.08 mm.

Holotype (Cushman Coll. No. 22242) from Green clay, Canyon III, Tow 9, Georges Bank.

NODOGENERINA GEORGIANA Cushman, n. sp. (Pl. 12, fig. 16)

Test elongate, somewhat tapering, nodose, composed of 6 or more subglobular chambers increasing rather regularly in size as added; sutures distinct, very much depressed; wall ornamented by numerous longitudinal costae extending backward nearly to the base of the chamber, and ending in short spinose projections; aperture terminal, rounded, at the end of a short neck, distinct, thickened, everted lip. Length 1.10 mm.; diameter 0.25 mm.

Holotype (Cushman Coll. No. 22244) from Greensand, Canyon III, Tow 9, Georges Bank.

This species has a very distinctive ornamentation which should distinguish it from other known species of the genus. In the

last-formed chamber, the base extends down over the neck of the previous chamber, and sometimes leaves a sort of collar between it and the previous chambers.

LOXOSTOMUM GEORGIANUM Cushman, n. sp. (Pl. 12, figs. 14, 15)

Test elongate, tapering, very slightly compressed, periphery broadly rounded; chambers distinct, numerous, biserial, the later ones tending to become uniserial, increasing gradually in height and size as added; sutures distinct, slightly depressed, oblique, forming an angle of about 45° with the horizontal in most of the test; wall coarsely perforate on the lower half of each chamber, upper portion usually smooth; aperture terminal, elliptical with a distinct, thickened lip. Length 0.60 mm.; thickness 0.10 mm.

Holotype (Cushman Coll. No. 22245) Greensand, Canyon III, Tow 9, Georges Bank.

Genus UNICOSIPHONIA Cushman, n. gen.

Genoholotype, *Unicosiphonia crenulata* Cushman, n. sp.

Test elongate, more or less tapering, uniserial throughout; chambers crenulate at the margin with backwardly projecting, somewhat overlapping processes; sutures distinct, depressed, at right angles to the elongate axis; wall calcareous, finely perforate; aperture rounded, terminal, with a distinct neck and slight lip connecting with an internal, tubular structure connecting the earlier apertures.

As yet this genus is only known from the type species.

UNICOSIPHONIA CRENULATA Cushman, n. sp. (Pl. 12, figs. 9, 10)

Test elongate cylindrical, initial end broadly rounded, apertural end somewhat truncate, sides nearly parallel, circular in transverse section; chambers uniserial throughout, on the very earliest showing traces of a biserial stage, of rather uniform size and shape, slightly overlapping, the base extended backward into definite lobulate projections; sutures distinct, depressed, crenulate; walls ornamented with a few, 8 to 10, longitudinal costae which become obsolescent toward the apertural end; aperture terminal, circular, rounded, with a distinct cylindrical neck in a depression of the terminal face, with a slight neck and an internal tube connecting with the previous apertures. Length 1.00 mm.; diameter 0.30 mm.

Holotype (Cushman Coll. No. 22247) Greensand, Canyon III, Tow 9, Georges Bank.

In its general appearance this species resembles some of those belonging to *Siphogenerina*, but the initial end in all our specimens is broadly rounded, and except for slight traces of a biserial condition in the very earliest chambers, the test is uniserial throughout.

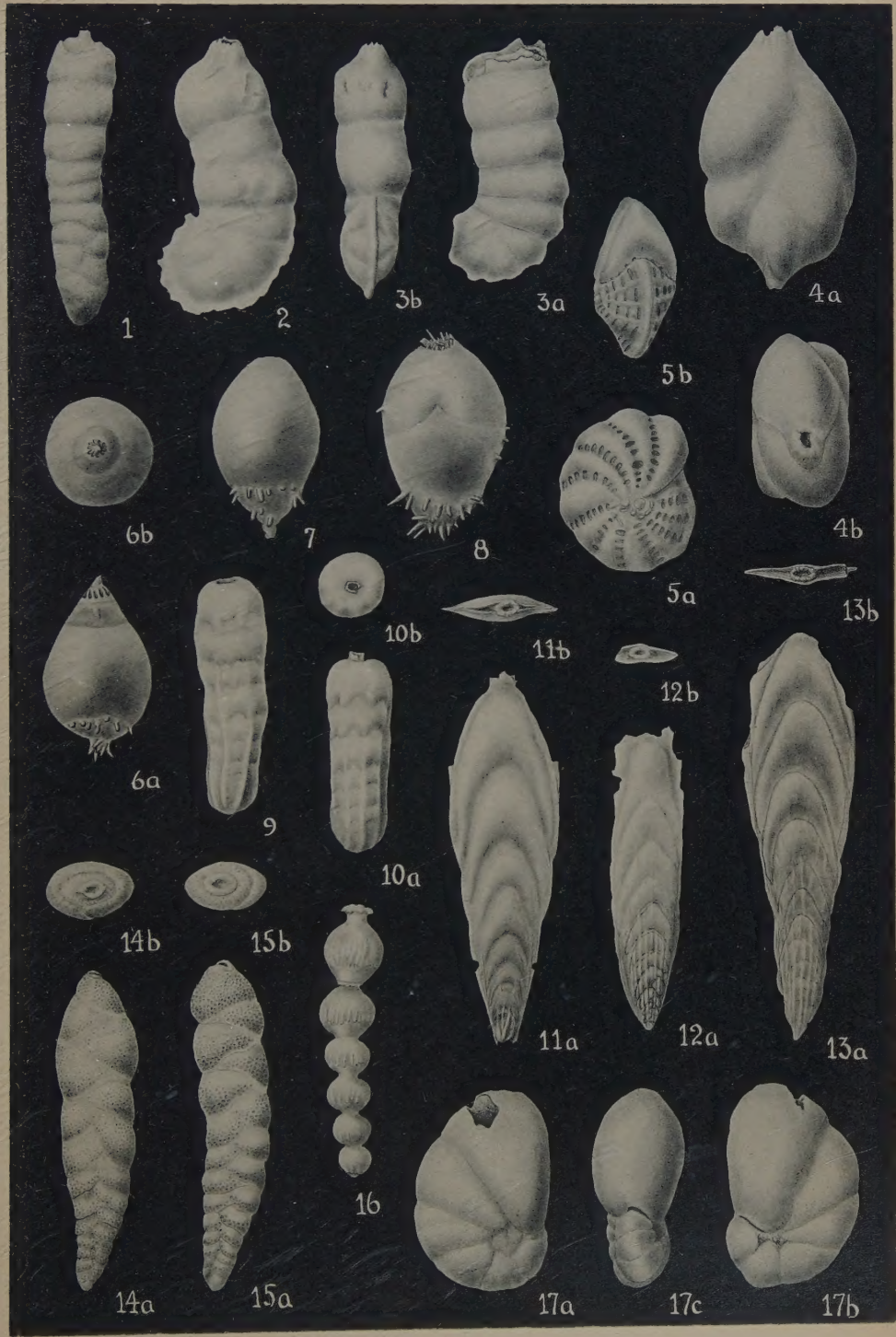
VALVULINERIA GEORGIANA Cushman, n. sp. (Pl. 12, figs. 17 a-c)

Test somewhat longer than broad, trochoid, dorsal side slightly evolute at the last whorl, ventral side almost completely involute, periphery very broadly rounded; chambers distinct, somewhat inflated, 6 or 7 in the adult whorl, increasing rather rapidly in length in the adult; sutures distinct, depressed, nearly radial;

EXPLANATION OF PLATE 12

- FIG. 1. *Listerella nodulosa* (Cushman), var. *glabrata* Cushman, n. var. $\times 48$.
- FIGS. 2, 3. *Marginulina georgiana* Cushman, n. sp. $\times 22$. Fig. 2, Holotype. Fig. 3, Paratype. *a*, side view; *b*, peripheral view.
- FIG. 4. *Guttulina georgiana* Cushman, n. sp. $\times 27$. *a*, front view; *b*, apertural view.
- FIG. 5. *Elphidium georgianum* Cushman, n. sp. $\times 33$. *a*, side view; *b*, apertural view.
- FIGS. 6-8. *Glandulina basi-spinata* Cushman, n. sp. $\times 33$. Fig. 6, Holotype. *a*, front view; *b*, apertural view. Figs. 7, 8, Paratypes.
- FIGS. 9, 10. *Unicosiphonia crenulata* Cushman, n. gen. and n. sp. $\times 33$. Fig. 10, Holotype. *a*, front view; *b*, apertural view. Fig. 9, Paratype.
- FIG. 11. *Plectofrondicularia basi-spinata* Cushman, n. sp. $\times 27$. *a*, front view; *b*, apertural view.
- FIG. 12. *Plectofrondicularia angusti-costata* Cushman, n. sp. $\times 33$. *a*, front view; *b*, apertural view.
- FIG. 13. *Plectofrondicularia georgiana* Cushman, n. sp. $\times 27$. *a*, front view; *b*, apertural view.
- FIGS. 14, 15. *Loxostomum georgianum* Cushman, n. sp. $\times 80$. Fig. 14, Holotype. Fig. 15, Paratype. *a, a*, front views; *b, b*, apertural views.
- FIG. 16. *Nodogenerina georgiana* Cushman, n. sp. $\times 33$.
- FIG. 17. *Valvulineria georgiana* Cushman, n. sp. $\times 33$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

Figures drawn by Patricia G. Edwards.



wall smooth, finely perforate; aperture a narrow, elongate slit at the base of the last chamber running from the periphery to the umbilicus. Length 0.90 mm.; breadth 0.60 mm.; thickness 0.35 mm.

Holotype (Cushman Coll. No. 22249) from Greensand, Canyon III, Tow 9, Georges Bank.

This species is unlike any of the others of the genus, but somewhat resembles some of the species known from the Pacific.

161. NOTES ON SOME AMERICAN CRETACEOUS FLABELLINAS

By JOSEPH A. CUSHMAN*

There are several species of *Flabellina* in the Upper Cretaceous of the southern United States and related regions which are related to, or identical with, some of the species which have long been described from the Upper Cretaceous of Europe. These species have been in some cases wrongly identified as is shown by a study of topotype material and a re-study of type descriptions.

In order to straighten out the nomenclature of some of the species, the following notes and descriptions are given with references to the literature to help in the identification of the species. A number of photographs will be found on the accompanying plate.

FLABELLINA RUGOSA d'Orbigny (Pl. 13, figs. 1-6)

Flabellina rugosa D'ORBIGNY, Mém. Soc. Géol. France, 1840, p. 23, pl. 2, figs. 4, 5, 7.—REUSS, in Geinitz, Grundr. Verstein, 1845-46, p. 658, pl. 24, fig. 23.—D'ORBIGNY, Prodrôme Pal., vol. 2, 1850, p. 281, No. 1379.—REUSS, Denkschr. Akad. Wiss. Wien, vol. 7, 1854, p. 67; Sitz Akad. Wiss. Wien, vol. 40, 1860, p. 215; vol. 52, abt. 1, 1865, p. 453.—KARRER, Jahrb. k. k. geol. Reichsanst., vol. 20, 1870, p. 176.—MARSSON, Mitth. nat. Ver. Neu-Vorpommern u. Rügen, Jahrb. 10, 1878, p. 140.—GOËS, Kongl. Svensk. Vet.-Akad. Handl., vol. 15, pt. 4, No. 2, 1889, pl. 2, fig. 4.—BEISSEL, Abhandl. kön. Preuss. geol. Landes, n. ser., vol. 3, 1891, p. 47, pl. 9, figs. 20-24; pl. 16, figs. 30,

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- 31.—EGGER, Abhandl. kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 108, pl. 10, figs. 5, 6; pl. 13, figs. 1, 2; Ber. nat. Ver. Passau, 1907, p. 30, pl. 1, fig. 8.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 3, 1927, p. 189.—BROTZEN, Zeitschr. Deutsch. Palästina-Vereins, Jahrg. 1934, p. 45.
- Flabellina interpunctata* VON DER MARCK, Verh. nat. Ver. preuss. Rheinlands, vol. 15, 1858, p. 53, pl. 1, fig. 5.—REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 216, pl. 9, fig. 1.—HERON-ALLEN and EARLAND, Journ. Roy. Micr. Soc., 1910, p. 422, pl. 8, fig. 5.—FRANKE, Bronn. Verh. Nat. Hist. Ver., vol. 59, 1912 (1913), p. 277.—CHAPMAN, Bull. Geol. Surv. W. Australia, No. 72, 1917, p. 34, pl. 10, fig. 91.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 64, pl. 5, fig. 13; Abhandl. Preuss. Geol. Landes, n. ser., vol. 111, 1928, p. 92, pl. 8, fig. 17.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 30, pl. 4, figs. 16, 17; Journ. Pal., vol. 5, 1931, p. 307, pl. 35, fig. 9.—PLUMMER, Bull. 3101, Univ. Texas, 1931, p. 163, pl. 12, figs. 1-3.—CUSHMAN, Journ. Pal., vol. 6, 1932, p. 336.—SANDIDGE, Amer. Midland Nat., vol. XIII, 1932, p. 194, pl. 19, figs. 12-14; Journ. Pal., vol. 6, 1932, p. 279, pl. 42, fig. 21.
- Frondicularia projecta* CARSEY, Bull. 2612, Univ. Texas, 1926, p. 41, pl. 6, fig. 5.
- Flabellina projecta* PLUMMER, l. c., Bull. 3101, 1931, p. 165, pl. 12, figs. 5-8.
- Frondicularia baudouiniana* CUSHMAN (not D'ORBIGNY), Contr. Cushman Lab. Foram. Res., vol. 2, pt. 1, 1926, p. 21, pl. 3, fig. 5; Journ. Pal., vol. 1, 1927, p. 155, pl. 24, fig. 13.

Test sagittate to rhomboid or even broadly elliptical in outline, much compressed, sides nearly flat, periphery truncate; early chambers coiled, especially in the microspheric form, later ones chevron-shaped, narrow and of uniform width, extending back on both sides, often at first nearly enclosing the earlier coiled chambers; sutures raised and sharp, later chambers with a loop at the apical end; wall between the raised sutures with a series of small, raised papillae; apertural end projecting, with a slight neck. Length up to 1.20 mm.; breadth 1.00 mm.

This species was originally described by d'Orbigny from the Upper Cretaceous "Craie blanche" of the Paris Basin. The type figures do not show any of the surface ornamentation except the sutures. However, d'Orbigny's original description includes the following, "couvert partout de granulations inégales." Figures 1 and 2 on our plate are from the White Chalk of the Paris Basin, and show the typical ornamented surface. Another of the characters which is not shown in the type figures, but which is distinct in most specimens, is the peculiar semicircular structure at the upper angle of each chamber at the median line of the test.

This is noted in d'Orbigny's description as follows, "toutes marquées sur leurs sutures d'une crête saillante venant former un demi-cercle en avant du sommet de chaque loge."

These two sets of characteristics are very well marked in the type specimens and also in the American species, although our figured specimens, most of which are not completely mature, do not show the semicircular markings as clearly as in some other specimens. It has been interesting to see in European collections that this species was correctly named by Karrer in his Austrian material and also by Dr. Franke. From a study of toptype material of the other species noted in the references, *Flabellina interpunctata* of von der Marck is a definite synonym of d'Orbigny's *F. rugosa*, and the two have the same general vertical range in Europe, in general the equivalent of the Taylor formation of America. In the American Cretaceous it is a characteristic species of the general Taylor series and its equivalents occurring in the Saratoga chalk, Pecan Gap chalk, Wolfe City sand, Annona chalk and Selma chalk. The following species which is somewhat similar but much more ornate, occurs much higher in the series in Trinidad. The form described by Mrs. Carsey as *F. projecta* seems to be indistinguishable from d'Orbigny's species, although the base becomes covered by the chamber extensions. There are, however, all gradations apparent in the same series from a single locality, and this form has been placed in the synonymy. The form described as *F. delicatissima* Plummer from the Midway formation of Texas also seems to occur in only one locality from the Arkadelphia Clay.

FLABELLINA JARVISI Cushman, n. sp. (Pl. 13, figs. 7, 8)

Flabellina interpunctata CUSHMAN and JARVIS (not VON DER MARCK),
Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1931, p. 38, pl. 12, fig. 1.

Test elongate, rhomboid or semi-elliptical, much compressed, sides flattened, periphery truncate; earliest chambers coiled but very quickly followed by typical chevron-shaped ones, each newly added one failing to extend over the preceding one on the periphery, narrow, of uniform width; sutures very high and plate-like, at the apical end of each chamber ending in one or several semicircular loops; surface between the sutures strongly papillate; aperture radiate, somewhat projecting. Length 1.50 mm.; breadth 0.80 mm.

Holotype (Cushman Coll. No. 15396) from Upper Cretaceous,

pit at Lizard Springs, near Guayaguayare, southeastern Trinidad, collected by P. W. Jarvis. The species also occurs in Trinidad in Cretaceous boulders in conglomerate on "Bon Accord" estate, 1/4 mile from Pointe-à-Pierre R. R. station, San Fernando, Trinidad, also collected by Mr. Jarvis.

This species is a more accelerated one than *F. rugosa* d'Orbigny with a much narrower test, fewer coiled chambers, the sutures very high and plate-like with numerous semicircular or irregularly shaped loops. Somewhat similar specimens occur in the uppermost Cretaceous of Mexico.

FLABELLINA SUTURALIS Cushman, n. sp. (Pl. 13, figs. 9-18)

Flabellina rugosa HERON-ALLEN and EARLAND (not D'ORBIGNY), Journ. Roy. Micr. Soc., 1910, p. 422, pl. 8, fig. 7.—FRANKE, Abhandl. geol. pal. Institut. Univ. Greifswald, vol. 6, 1925, p. 64, pl. 5, fig. 12; Abhandl. Preuss. Geol. Landes, n. ser., vol. 111, 1928, p. 92, pl. 8, figs. 18 a, b.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 32, pl. 4, fig. 15; Journ. Pal., vol. 5, 1931, p. 307, pl. 35, fig. 10.—PLUMMER, Bull. 3101, Univ. Texas, 1931, p. 166, pl. 12, fig. 4.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 7, 1931, p. 38, pl. 5, fig. 3.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 279, pl. 42, fig. 22.

Test rhomboid or somewhat cordate at the base, much compressed, periphery truncate; chambers of the early portion coiled, usually forming a single coil or less before the chevron-shaped chambers are developed, width of the chambers increasing gradually as the test develops; sutures very distinct, very high and plate-like in the earliest portion, thence less high as development progresses, outer apical portion somewhat convex but not ending in a separate loop; wall smooth, polished; aperture radiate, terminal, often with a slight neck. Length 2.00 mm.; breadth 1.50 mm.

Holotype (Cushman Coll. No. 22207) from Taylor marl, 20 feet above top of Marlin chalk, Waco road, 1 mile W.S.W. of Prairie Hill, Limestone Co., Texas.

This species which has been confused with *Flabellina rugosa* d'Orbigny is rather widely distributed in the American Upper Cretaceous, ranging through the Austin upward into the lower and middle Taylor and its equivalents. It is apparently also in Europe where it has also been confused with *F. rugosa*. It occurs also in the Cretaceous of the West Indies and Venezuela. In some respects *F. suturalis* resembles *F. rugosa*, but the sutures are usually higher, the intermediate surface smooth, and loops

are not typically developed at the apical end of the chambers. The two species occur together in but four of the more than sixty stations from which I have had material of the two species.

This species occurs in the Taylor and its equivalent, the Pecan Gap chalk, Ozan, Annona chalk and Selma chalk. It also occurs at a number of stations in the Austin chalk.

Occasionally specimens show slight traces of ornamentation between the sutures, but these are very infrequent. There is a tendency for the earlier sutures to be very prominent and much raised above the general surface, while later ones are hardly, if at all, raised.

FLABELLINA RETICULATA Reuss (Pl. 13, fig. 19)

- Flabellina reticulata* REUSS, in Haidinger's Nat. Abhandl., vol. 4, pt. 1, 1851, p. 30, pl. 1, fig. 22; Sitz. Akad. Wiss. Wien, vol. 44, pt. 1, 1861 (1862), p. 326.—OLSZEWSKI, Sprawozd. Kon. Fizyj. Akad. Umiej. Krakowie, vol. 9, 1875, p. 110.—MARSSON, Mitth. Nat. Ver. New-Vorpommern u Rügen, Jahrb. 10, 1876, p. 139.—EGGER, Abhandl. Kön. bay. Akad. Wiss. München, Cl. II, vol. 21, 1899, p. 107, pl. 13, figs. 5-7.—FRANKE, Abhandl. geol. pal. Instit. Univ. Greifswald, vol. 6, 1925, p. 64, pl. 5, fig. 14; Abhandl. Preuss. Geol. Landes., vol. 111, 1928, p. 93, pl. 8, fig. 19.—WHITE, Journ. Pal., vol. 2, 1928, p. 204, pl. 28, fig. 15.—CUSHMAN, Contr. Cushman Lab. Foram. Res., vol. 6, 1930, p. 32, pl. 4, figs. 18, 19.—CUSHMAN and JARVIS, Proc. U. S. Nat. Mus., vol. 80, Art. 14, 1931, p. 37, pl. 11, fig. 15.—BROTZEN, Zeitschr. Deutsch. Palästina-Vereins, Jahrg. 1934, p. 46.
- Fronicularia reticulata* BAGG, Bull. 88, U. S. Geol. Survey, 1898, p. 50, pl. 3, fig. 6.—WELLER, Geol. Survey New Jersey, Paleontology, vol. 4, 1907, p. 230, pl. 2, fig. 30.—PLUMMER, Bull. 2044, Univ. Texas, 1927, pp. 39, 172, pl. 2, fig. 5.
- Flabellina favosa* BEISSEL, Abhandl. Kön. Preuss. geol. Landes., vol. 3, 1891, p. 49, pl. 19, figs. 25-28; pl. 26, fig. 28.
- Fronicularia* cf. *interpunctata* CUSHMAN (not VON DER MARCK), Bull. Amer. Assoc. Petr. Geol., vol. 10, No. 6, 1926, p. 598, pl. 20, fig. 6.

Test much compressed, sides nearly or quite flat, outline of test variable, rhomboid or the base rounded, even lobed, periphery truncate, early portion coiled, later chambers extending back on both sides; chambers distinct, chevron-shaped, narrow; sutures distinct, raised somewhat, the surface of the test between covered by a raised network of octagonal meshes with the long axis at right angles to the sutures; aperture slightly produced, radiate. Length up to 2.00 mm.; breadth 1.50-2.00 mm.

This species was originally described from the Upper Cretaceous of Europe, and there occurs rather widely distributed in

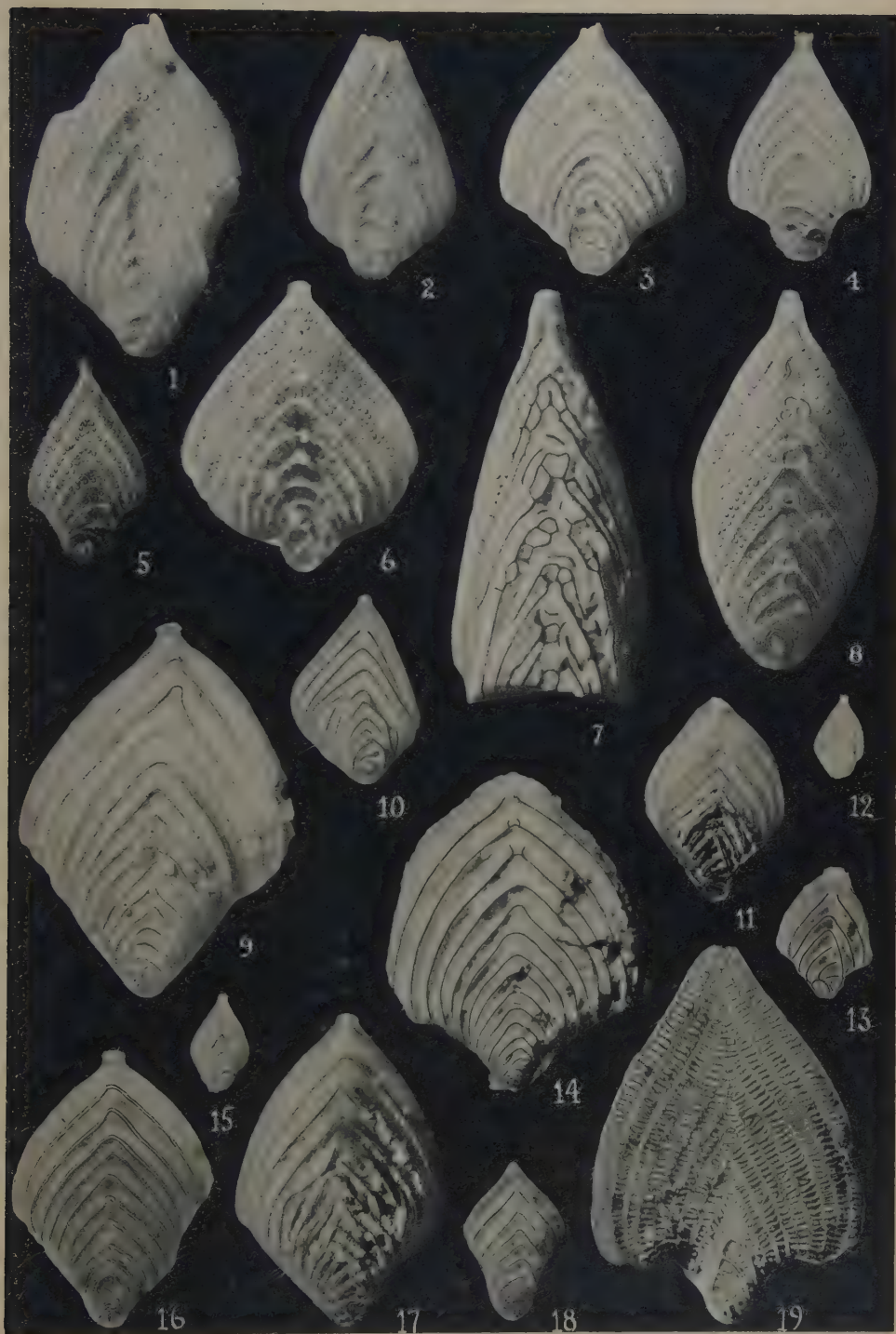
the uppermost Cretaceous. Topotype material of Reuss' species from Lemberg have been studied and also topotype material of Beissel's species *Flabellina favosa* from the Upper Cretaceous of Friedrichsberg near Aachen. The two are evidently synonyms. Most of the European material I have seen is rather rhomboid in outline, while most of the American specimens are cordate. There are, however, many specimens which seem to bridge over these differences in shape. The range both in Europe and America is very similar, limited to the uppermost Cretaceous.

In our American Cretaceous material the species is limited to the Navarro or its equivalents with one exception. That is material designated as Upper Taylor, from the Marquez Salt Dome, Leon Co., Texas. The species is particularly abundant in the "*Bulimina*-zone" of the Navarro.

This species occurs in the Arkadelphia clay and at many stations in the Navarro, a single locality in the Nacatoch sand, and also occurs in the Oktobbeha tongue of the Selma chalk in Mississippi where many other typically Navarro species occur. In the Upper Cretaceous of Trinidad and Mexico, a somewhat

EXPLANATION OF PLATE 13

- FIGS. 1-6. *Flabellina rugosa* d'Orbigny. Figs. 1, 2, $\times 33$, from Upper Cretaceous "Craie blanche" of Bougival, France. Figs. 3, 6, $\times 36$, from Taylor marl, 20 feet above top of Marlin chalk member, 1 mile W.S.W. of Prairie Hill, Limestone Co., Texas. Figs. 4, 5, $\times 36$, from Taylor marl, Paris highway, 2.4 miles W. by N. of Bogata, Red River Co., Texas.
- FIGS. 7, 8. *Flabellina jarvisi* Cushman, n. sp. $\times 36$. Fig. 7, Paratype. From $\frac{1}{4}$ mile from Pointe-à-Pierre R. R. Sta., San Fernando, Trinidad. Apertural portion of adult showing multiple loops. Fig. 8, Holotype. From pit at Lizard Springs, near Guayaquayare, Trinidad.
- FIGS. 9-18. *Flabellina suturalis* Cushman, n. sp. Figs. 9, 13, 16, 18, $\times 22$. From Taylor marl 20 feet above top of Marlin chalk member, 1 mile W.S.W. of Prairie Hill, Limestone Co., Texas. Figs. 10, 11, 12, 14, 15, 17, $\times 20$. Figs. 11, 17, From Taylor marl, well samples. Figs. 10, 12, 15, From upper part of Austin chalk, gully south of Hillsboro-Corsicana road, 10 miles east of Hillsboro, Texas. Fig. 14, Upper Gober chalk, Austin, cut on T. P. R. R., 2.2 miles west of High, Lamar Co., Texas.
- FIG. 19. *Flabellina reticulata* Reuss. $\times 30$. Navarro formation. Clay pit near Corsicana, Texas.
From micro-photographs by Frances L. Parker.



similar species, *F. semi-reticulata* Cushman and Jarvis, occurs. In this form the reticulation is much more irregular and the sides of the reticulations are much shortened giving a very different appearance to the test.

162. A NEW GENUS OF FORAMINIFERA, DISCORBINELLA, FROM MONTEREY BAY, CALIFORNIA

By JOSEPH A. CUSHMAN and LOIS T. MARTIN

In an intensive study of the Recent Foraminifera of Monterey Bay by the junior author, numerous interesting foraminifera have been found. The following genus has been checked with described forms, and appears to be new.

Genus DISCORBINELLA Cushman and Martin, n. gen.

Genoholotype, *Discorbinella montereyensis* Cushman and Martin, n. sp.

Test trochoid, *Discorbis*-like; wall calcareous, finely perforate, hyaline; aperture consisting mainly of an elongate opening near the base of the apertural face in the axis of coiling, with a distinctly thickened lip, and a supplementary, often poorly developed aperture at the inner margin of the ventral face of the last-formed chamber, beneath a distinct flap-like projection of the chamber margin.

DISCORBINELLA MONTEREYENSIS Cushman and Martin, n. sp. (Pl. 14, figs. 13 a-c)

Test free, trochoid, strongly compressed, not completely involute, the entire coil visible from both sides, periphery keeled, dorsally very slightly concave at the umbilical area; chambers on the dorsal side slightly inflated, ventrally flattened, the umbilical area on this side tending to become concave; sutures limbate, curved, more strongly on dorsal than ventral side; wall finely perforate, hyaline; aperture an elongate slit with thickened lip in the plane of coiling, on ventral side the last three chambers, more or less, extending toward the umbilical area in rounded flap-like projections, with traces of a rudimentary *Discorbis*-like aperture under flap of last-formed chamber.

Length 0.35-0.50 mm.; breadth 0.27-0.37 mm.; thickness 0.08-0.12 mm.

Holotype (Cushman Coll. No. 22345) from the intertidal area (Leland Stanford Jr. University Locality No. 1164) of Monterey Bay, California, to a depth of 41 fathoms, (in samples from L. S. J. U. Loc. No. 1492).

163. NEW SPECIES OF FORAMINIFERA FROM THE KREYENHAGEN SHALE OF FRESNO COUNTY, CALIFORNIA

By JOSEPH A. CUSHMAN and STANLEY S. SIEGFUS

The Kreyenhagen shale formation was originally described in 1905 by F. M. Anderson* for the Eocene shales exposed near the Kreyenhagen wells at Canoas Creek. In the confusion that has resulted from the correlation of this formation, it has been apparent that more information was needed regarding the type locality at Canoas Creek. After considerable study in this area starting in 1932, it was found that because of the poor outcrops and heavy overburden, there was still much to be desired for a better understanding of this formation. Accordingly, the Garza Creek area, a little less than three miles to the southeast, was sampled and described in detail. The Garza Creek section was found to be far more complete and very much better exposed. Because of certain rather definite zones which will be described later in a separate paper by the junior author, correlations between the two localities can be made with considerable assurance. For a better understanding of the type locality of the Kreyenhagen shale formation, the Garza Creek section can well be used instead of the original Canoas Creek section.

The general features of the Kreyenhagen shale are described in the U. S. G. S. Bulletin No. 398 in connection with the Upper or shaley part of the Eocene (Tejon) formation. Studies by the junior author have shown that the formation has been affected by faulting throughout its extent south of Coalinga. Of all the

* Anderson, F. M., Cal. Acad. Sci., ser. 3, vol. II, No. 2, 1905, p. 163.

areas, the Garza Creek section appears to have been the least affected. In the region of the Canoas Creek, it is slightly less than one thousand feet in thickness, and underlies a zone of fine gray sand 35—158 feet in thickness, which is likely Vaqueros in age. The lower limit is the base of a zone of greenish-gray, silty shale which conformably overlies the Avenal sandstone in this area.

The age of the Kreyenhagen has been somewhat in doubt, but attention is here called to the occurrence of *Hantkenina*, as well as to the following: *Rhabdammina eocenica* Cushman and Hanna, *Bathysiphon eocenica* Cushman and Hanna, *Bolivinospis* sp(?) cf. Nuttall from Upper Eocene of Venezuela, *Cibicides venezuelana* Nuttall, *Cassidulina globosa* Hantken, *Uvigerina* cf. *jacksonensis* Cushman, *Gyroidina soldanii* (d'Orbigny) var. *octocamerata* Cushman and Hanna, together with many others. The following species appear to be new:

VULVULINA CURTA Cushman and Siegfus, n. sp. (Pl. 14, figs. 1, 2)

Test nearly as broad as long, compressed, periphery acute, spinose in the biserial portion; chambers rather indistinct, earliest ones planispiral, later biserial ones low and broad, of rather uniform height, the peripheral portion ending in a short, pointed spine, uniserial chambers only one or two, much narrower than the preceding portions of the test; sutures mostly indistinct except in the uniserial portion where they are distinctly depressed; wall finely arenaceous, mostly smooth; aperture in the uniserial portion elongate, elliptical, terminal. Length 0.60 mm.; breadth 0.50 mm.

Holotype (Cushman Coll. No. 22347) from Kreyenhagen shale, Garza Creek, San Joaquin Valley, California.

This species resembles most closely *Vulvulina advena* Cushman from the Eocene of the Gulf Coastal Plain region of the United States. The California species does not have as many uniserial chambers, and is more contracted laterally. It also resembles the form described by Nuttall as *Vulvulina pectinata* Hantken, var. *mexicana*, but the biserial chambers in our species are relatively broader, and the angles of the sutures much greater. The uniserial portion is also more prominent.

PLECTINA GARZAENSIS Cushman and Siegfus, n. sp. (Pl. 14, figs. 3, 4)

Test elongate, subcylindrical or slightly tapering from the greatest breadth near the apertural end, somewhat nodose, nearly circular in transverse section, earliest whorl with more than three chambers, then triserial, biserial in the adult or tending to become uniserial; chambers of the early portion indistinct, later ones somewhat inflated, increasing in height as added; sutures indistinct in the early stages, later more distinct and depressed; wall coarsely arenaceous, somewhat roughly finished; aperture in the adult nearly terminal, rounded, without a neck. Length up to 0.90 mm.; diameter 0.30-0.40 mm.

Holotype (Cushman Coll. No. 22350) from Kreyenhagen shale of Garza Creek, San Joaquin Valley, California.

This most closely resembles an Upper Eocene species from southern Europe, but is more slender and smaller than the European one.

TRITAXILINA COLEI Cushman and Siegfus, n. sp. (Pl. 14, figs. 5, 6)

Test $1\frac{1}{2}$ -2 times as long as broad, somewhat tapering at the base, and having its greatest breadth near the middle, the adult again tapering somewhat toward the apertural end, rounded in transverse section; chambers in the early portion with more than three to a whorl, having a distinct four-chambered stage, after which triserial, and then biserial chambers are developed; sutures distinct, slightly depressed; wall rather coarsely arenaceous, the basal portion of each chamber somewhat raised; aperture nearly terminal in the adult, and the whole test tending to become somewhat uniserial at that stage. Length 0.60-0.75 mm.; diameter 0.30 mm.

Holotype (Cushman Coll. No. 9500) from the Eocene, Chapapote formation, Chapapote, Mexico. Collected by W. S. Cole.

The species occurs in typical form in our material from the Kreyenhagen shales of Garza Creek. This is the same species as that occurring in the Upper Eocene of Mexico.

BULIMINA CORRUGATA Cushman and Siegfus, n. sp. (Pl. 14, figs. 7 a, b)

Test elongate, tapering, fusiform, greatest breadth above the middle, somewhat triangular in transverse section, angles bluntly rounded; chambers indistinct except the last three which are somewhat inflated, rather low and only slightly overlapping; sutures indistinct except in the later portion where they are dis-

tinctly depressed; wall covered by the longitudinal costae which are high and sharp, running from the initial end to the base of the last-formed chamber, continuous over the sutures, last-formed chamber smooth, distinctly perforate; aperture a rather broad, elongate opening, slightly if at all curved with a slight lip. Length 0.35-0.45 mm.; diameter 0.25 mm.

Holotype (Cushman Coll. No. 22354) from Kreyenhagen shale, Lower Garza Creek, California, 573 feet below top of Kreyenhagen.

This species somewhat resembles *B. rostrata* H. B. Brady. Our specimens have no basal spine. This is a very common species in this material, and should make a good marker.

BULIMINA GARZAENSIS Cushman and Siegfus, n. sp. (Pl. 14, figs. 8 a, b)

Test fusiform, greatest breadth above the middle, nearly circular in transverse section, initial end subacute or acute with a short spine, apertural end usually somewhat truncately rounded; chambers fairly distinct, especially toward the apertural end where they are inflated; sutures of the earlier portion indistinct, later somewhat depressed; wall except for the last whorl of chambers ornamented by longitudinal costae which are largely confined to the individual chamber to form an irregular reticulate pattern of variously shaped, depressed areas; aperture somewhat longer than broad, slightly curved, with a raised lip. Length 0.50-1.00 mm.; diameter 0.30-0.65 mm.

Holotype (Cushman Coll. No. 22356) from Kreyenhagen shale, Garza Creek, California.

This species is a very variable one belonging to the general group of *B. inflata*. The basal ends of the costae are not produced into spines, and the surface varies from one with a main ornamentation of continuous longitudinal costae to an irregularly reticulate surface.

BULIMINA CURTISSIMA Cushman and Siegfus, n. sp. (Pl. 14, figs. 9 a, b)

Test short and broad, only slightly longer than broad, fusiform in front view, greatest breadth somewhat below the middle, thence tapering to either end, initial end acute and spinose; chambers comparatively few, strongly inflated, increasing rapidly in size as added, the last whorl making a very large part of the surface of the test, much overlapping, the base with a few very short spines; sutures distinct, slightly depressed; wall smooth,

finely perforate; aperture elongate, slightly curved, with a slight lip. Length 0.30-0.35 mm.; diameter 0.22-0.25 mm.

Holotype (Cushman Coll. No. 22352) from Kreyenhagen shale, Upper Garza Creek, California, 83 feet below top of Kreyenhagen.

This is a very short species with strongly inflated chambers.

ASTERIGERINA CRASSAFORMIS Cushman and Siegfus, n. sp. (Pl. 14, figs. 10 a-c)

Test trochoid, plano-convex, dorsal side flattened, ventral side very strongly convex, especially in the central portion, completely involute, periphery acute, slightly keeled; chambers distinct, 6 or 7 in the adult whorl, dorsally narrow, much overlapping, of rather uniform size and shape, ventrally with rhomboid supplementary chambers forming an inner ring about an umbonate central area of clear shell material; sutures very distinct, very slightly limbate, dorsally very oblique, ventrally nearly radial and slightly depressed; wall smooth, finely perforate; aperture a

EXPLANATION OF PLATE 14

- FIGS. 1, 2. *Vulvulina curta* Cushman and Siegfus, n. sp. $\times 60$. Fig. 1, Holotype. *a*, front view; *b*, apertural view. Fig. 2, Paratype.
- FIGS. 3, 4. *Plectina garzaensis* Cushman and Siegfus, n. sp. $\times 45$. Fig. 3, Holotype. *a*, front view; *b*, apertural view. Fig. 4, Paratype.
- FIGS. 5, 6. *Tritaxilina colei* Cushman and Siegfus, n. sp. $\times 40$. Fig. 6, Holotype, from Chapapote, Mexico. Fig. 5, From Garza Creek, California. *a*, front view; *b*, apertural view.
- FIG. 7. *Bulimina corrugata* Cushman and Siegfus, n. sp. $\times 80$. *a*, front view; *b*, apertural view.
- FIG. 8. *Bulimina garzaensis* Cushman and Siegfus, n. sp. $\times 80$. *a*, front view; *b*, apertural view.
- FIG. 9. *Bulimina curtissima* Cushman and Siegfus, n. sp. $\times 85$. *a*, front view; *b*, apertural view.
- FIG. 10. *Asterigerina crassaformis* Cushman and Siegfus, n. sp. $\times 80$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIG. 11. *Pulvinulinella tennicarinata* Cushman and Siegfus, n. sp. $\times 80$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIG. 12. *Anomalina crassisepta* Cushman and Siegfus, n. sp. $\times 60$. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.
- FIG. 13. *Discorbinella montereyensis* Cushman and Martin, n. gen. and n. sp. $\times 100$. Recent, Monterey Bay, California. *a*, dorsal view; *b*, ventral view; *c*, peripheral view.

Figures drawn by Patricia G. Edwards.



narrow opening in the middle of the base of the final chamber on the ventral side. Diameter 0.40-0.50 mm.; thickness 0.25-0.40 mm.

Holotype (Cushman Coll. No. 22358) from Kreyenhagen shale, Garza Creek, California, 510 feet below top of Kreyenhagen.

This is a very striking species of value as a stratigraphic marker.

PULVINULINELLA TENUICARINATA Cushman and Siegfus, n. sp. (Pl. 14, figs. 11 a-c)

Test trochoid, biconvex, periphery acute, strongly carinate, the carina irregularly toothed; chambers somewhat obscure due to the secondary thickening over the sutures which nearly covers the chambers, about ten in the adult whorl; sutures on the ventral side slightly curved, nearly radiate, strongly limbate and fused over the umbilical area, on the dorsal side much thickened and fused, covering nearly the whole surface; wall finely perforate; aperture a small opening in the axis of coiling just ventral to the peripheral keel. Diameter 0.45-0.65 mm.; thickness 0.30-0.40 mm.

Holotype (Cushman Coll. No. 22363) from Kreyenhagen shale, Canoas Creek, California.

This species has the chambers on the dorsal side almost completely hidden by the secondary growth of the sutural thickenings, and has a very thin toothed carina. It is fairly common also in the material from Garza Creek.

ANOMALINA CRASSISEPTA Cushman and Siegfus, n. sp. (Pl. 14, figs. 12 a-c)

Test trochoid in the early stages, becoming nearly planispiral in the adult, almost completely involute, periphery in early stages subacute, in adult broadly truncate; chambers distinct, about nine in the last-formed whorl, increasing rather uniformly in size as added, ventrally slightly inflated; sutures distinct, on the ventral side slightly curved and depressed, dorsally very much thickened, especially toward the inner end, strongly curved and merging into a peripheral, raised border; wall coarsely perforate; aperture a low opening at the peripheral margin at the base of the last-formed chamber, and continuing somewhat to the ventral side. Length 0.65-0.80 mm.; breadth 0.55-0.65 mm.; thickness 0.25-0.30 mm.

Holotype (Cushman Coll. No. 22360) from Kreyenhagen shale, Garza Creek, California.

This is a very common species in the Kreyenhagen, and should make a good index fossil.

164. SOME AMERICAN CRETACEOUS BULIMINAS

By JOSEPH A. CUSHMAN and FRANCES L. PARKER

During the summer of 1932 the authors spent considerable time in the study of type material, particularly the Cretaceous of Central Europe. In addition a study has been made of topotype material from those regions from which Cretaceous species of *Bulimina* have been described. As a result of these studies we have reached the conclusion that our American material is, in practically every case, distinct from that of other areas. One exception is *Bulimina reussi* Morrow which occurs in both European and American Cretaceous faunas.

These notes include only Cretaceous species from the Gulf Coastal Plain of the United States. The remaining American species will be included in a monographic study of the genus now nearing completion.

BULIMINA ARKADELPHIANA Cushman and Parker, n. sp. (Pl. 15, figs. 1 a, b, 2)

Test small to medium, the megalospheric form being considerably smaller than the microspheric, tapering; chambers numerous, about five whorls in the megalospheric form, eight in the microspheric, later ones inflated; sutures distinct, deep; wall, except for the last three chambers, covered with sharp spines, especially at the margins of the chambers, the last-formed whorl with spines at the margins of the chambers and with only an occasional spine above, finely perforate; aperture typically elongate with a small lip. Length 0.33-0.50 mm.; diameter 0.23-0.30 mm.

Holotype (Cushman Coll. No. 22365) from the Arkadelphia clay, 6 miles north by west of Hope, Hempstead Co., Arkansas.

This species was found in several stations in the Arkadelphia clay.

BULIMINA TAYLORENSIS Cushman and Parker, n. sp. (Pl. 15, figs. 3 a, b)

Test small, slightly tapering, about one and one-half times as long as broad except in the rare microspheric form which is almost twice as long as broad; chambers fairly distinct, 4-5 whorls in the megalospheric form, more in the microspheric, overlapping; sutures deep, their presence, except in the last-

formed whorl, chiefly indicated by the sharp undercutting below the chamber above; wall finely perforate with irregular costae spaced rather far apart, causing an irregular fluting of the sharp margin of the chambers, the initial end of the test with one or more spines; aperture an elongate, loop-shaped opening with a distinct lip, opening at the inner margin of the last-formed chamber. Length 0.27-0.32 mm.; diameter 0.20-0.21 mm.

Holotype (Cushman Coll. No. 22367) from the Upper Taylor, Branch of Kickapoo Creek, 1,200 feet south of the public road, 1.8 miles northwest of Annona, Red River Co., Texas.

This highly ornamented species was found in various stations in the Taylor, and further study would probably show that it occurs within a short range.

BULIMINA ORNATA Cushman and Parker, n. sp. (Pl. 15, figs. 4 a, b)

Test small, triangular in section with the angles rounded and the sides distinctly concave, occasionally slightly twisted on its axis; chambers numerous, 5-6 whorls, distinct, somewhat inflated, arranged in regular series with the adjacent series meeting in a zigzag line; sutures distinct, depressed, sigmoid, slanting at an angle of 45° with the horizontal; wall, except for the central portion of the chambers in the last-formed whorl, covered with short spines, perforate; aperture loop-shaped with a slight lip. Length 0.20-0.26 mm.; diameter 0.11-0.16 mm.

Holotype (Cushman Coll. No. 22368) from the Taylor, Paris highway, 1.8 miles east of Deport, Red River Co., Texas.

Specimens of this species were found in a few stations in the Taylor, and in one station in the Ector Tongue of the Austin chalk.

BULIMINA TRIANGULARIS Cushman and Parker, n. sp. (Pl. 15, figs. 6 a, b)

Test small, one and one-third times as long as broad, triangular in section with rounded angles and slightly concave sides; chambers indistinct, about five whorls; sutures very indistinct, showing only as a slightly darkened line; wall covered, on the bottom half with short irregular longitudinal ridges, which sometimes become slightly spinose, the upper half smooth, coarsely perforate; aperture loop-shaped with a slight lip. Length 0.21-0.28 mm.; diameter 0.15-0.17 mm.

Holotype (Cushman Coll. No. 22369) from the Upper Taylor, 3.9 miles east of Farmersville, Collin Co., Texas, on the Greenville road.

Specimens of this species were found in several Taylor stations, in two in the Selma chalk of Alabama, and in one Navarro station.

BULIMINA PROLIXA Cushman and Parker, n. sp. (Pl. 15, figs. 5 a, b)

Bulimina puschi CUSHMAN (not REUSS), Bull. 41, Tenn. Geol. Survey, 1931, p. 47, pl. 7, figs. 19 a, b.

Test long and narrow, about two and one-half times as long as broad, tapering very slightly through the whole length, triangular in section practically throughout with the angles broadly

EXPLANATION OF PLATE 15

- FIGS. 1, 2. *Bulimina arkadelphiana* Cushman and Parker, n. sp. $\times 85$. Fig. 1, Holotype. a, front view; b, apertural view. Arkadelphia clay, 6 mi. N. by W. of Hope, Hempstead Co., Arkansas. Fig. 2, Paratype. 4.5 miles east of Washington, $\frac{1}{2}$ mile N. of Reeds Store, Arkansas.
- FIG. 3. *Bulimina taylorensis* Cushman and Parker, n. sp. $\times 100$. a, front view; b, apertural view.
- FIG. 4. *Bulimina ornata* Cushman and Parker, n. sp. $\times 135$. a, front view; b, apertural view.
- FIG. 5. *Bulimina proluxa* Cushman and Parker, n. sp. $\times 110$. a, front view; b, apertural view.
- FIG. 6. *Bulimina triangularis* Cushman and Parker, n. sp. $\times 100$. a, front view; b, apertural view.
- FIG. 7. *Bulimina exigua* Cushman and Parker, n. sp. $\times 120$. a, front view; b, apertural view.
- FIGS. 8, 10. *Bulimina reussi* Morrow. $\times 100$. Fig. 8, a, front view; b, apertural view. From Wolfe City sand, Roadside ditch N. of McKinney-Farmersville road; 13.85 mi. E. of M. K. & T. R. R. tracks in McKinney, Texas. Fig. 10, Upper Austin, Ditch 1.4 mi. N. of Melissa on Sherman-McKinney highway, Texas.
- FIG. 9. *Bulimina trihedra* Cushman. $\times 80$. a, front view; b, apertural view. Velasco shale, Hacienda El Limon, Mexico.
- FIG. 11. *Bulimina reussi* Morrow, var. *navarroensis* Cushman and Parker, n. var. $\times 100$. a, front view; b, apertural view.
- FIGS. 12-16. *Bulimina quadrata* Plummer. $\times 70$. Fig. 12, Navarro, Mustang Creek, 6 mi. E.S.E. of Taylor, Williamson Co., Texas. Figs. 13, 14, Upper Taylor, branch of Kickapoo Creek, 1,200 ft. S. of public road, 1.8 mi. N.W. of Annona, Red River Co., Texas. 13, Megalospheric. a, front view; b, apertural view. Fig. 14, Microspheric. Fig. 15, Navarro, clay pit near Corsicana, Texas. Fig. 16, Upper Taylor, 7.5 mi. from Terrell, on road to Crandall, Kaufman Co., Texas.

Figures drawn by Ann Shepard.



U. asper

U. asper = *U. asper*

U. asper

rounded, often somewhat twisted on its axis toward the initial end; chambers numerous, 6-7 whorls, distinct, those of successive whorls placed directly over each other with adjacent series meeting in a zigzag line; sutures distinct, very slightly depressed; wall smooth, coarsely perforate; aperture elongate, well removed from the juncture of the third preceding chamber. Length 0.25-0.27 mm.; diameter 0.11-0.12 mm.

Holotype (Cushman Coll. No. 22370) from the Selma chalk, New Corinth highway, 13½ miles east of Selmer, McNairy Co., Tennessee.

This form has been wrongly identified as *Bulimina puschi* Reuss. A study of topotype material from Lemberg has definitely shown that species to be arenaceous. Specimens of our species were found in the Selma chalk of Tennessee and Mississippi, in one station in the Upper Taylor of Texas, and a similar form which, however, shows some variations, in the Coon Creek of Tennessee.

BULIMINA EXIGUA Cushman and Parker, n. sp. (Pl. 15, figs. 7 a, b)

Test very small, about twice as long as broad, gradually tapering; chambers distinct, overlapping, somewhat inflated, usually five whorls; sutures distinct, depressed throughout, forming a slight angle with the horizontal; wall smooth, perforate; aperture rounded. Length 0.10-0.17 mm.; diameter 0.08-0.11 mm.

Holotype (Cushman Coll. No. 22371) from the Lower Brownstown Marl (near base), Paris-Clarkesville highway, 1.85 miles southeast of Bagwell, Texas.

This form was found at two stations in the Brownstown Marl. It differs from *Bulimina reussi* Morrow in the more gradual increase in size of the chambers toward the apertural end, in the different shape of the aperture, and in its smaller size.

BULIMINA REUSSI Morrow (Pl. 15, figs. 8 a, b, 10)

Bulimina reussi MORROW, Journ. Pal., vol. 8, No. 2, 1934, p. 195, pl. 29, fig. 12.

Bulimina ovulum REUSS, Verstein. Bohm. Kreide, pt. 1, 1845, pl. 8, fig. 57; pl. 13, fig. 73 (not *Bulimina ovula* D'ORBIGNY, 1839).

Bulimina murchisoniana CUSHMAN (not D'ORBIGNY), Journ. Pal., vol. 5, 1931, p. 309, pl. 35, figs. 14 a, b; l. c., vol. 6, 1932, p. 340.

Our forms from the Cretaceous of Texas and Tennessee have been compared with topotype material of *Bulimina ovulum* Reuss with which they appear to be identical. This form has been re-

named *Bulimina reussi* by Morrow. The species was found in its typical form throughout the Taylor formation of Texas, and to a somewhat smaller extent in the Selma chalk of Tennessee and Mississippi. A smaller and somewhat more inflated form (Pl. 15, fig. 10) was found in the Austin chalk which, with further study, may be found to be a true variety.

BULIMINA REUSSI Morrow, var. **NAVARROENSIS** Cushman and Parker, n. var.
(Pl. 15, figs. 11 a, b)

This variety differs from the typical in the smaller size of the test and in the much slighter inflation of the last-formed chambers together with the much smaller proportion of the whole test which these chambers form. Length 0.16-0.25 mm.; diameter 0.10-0.13 mm.

Holotype of variety (Cushman Coll. No. 22372) from the Navarro formation, chalky marl member, San Marco River, $\frac{1}{2}$ mile below Martindale, Caldwell Co., Texas.

Specimens of this variety were found only in the Navarro, and occurred in a number of stations.

BULIMINA TRIHEDRA Cushman (Pl. 15, figs. 9 a, b)

Bulimina trihedra CUSHMAN, Bull. Amer. Assoc. Petr. Geol., vol. 10, 1926, p. 591, pl. 17, figs. 6 a, b; Journ. Pal., vol. 1, 1927, p. 160, pl. 27, fig. 5.

Two specimens of this small trihedral form were found, one in the Annona chalk of Texas and one in the Selma chalk of Mississippi. They compare very closely with the Mexican form from the Velasco shale. The holotype, here figured, is from the Velasco shale, Hacienda El Limon, Vera Cruz, Mexico, M. hole Z, 105 feet, Marland Oil Company of Mexico. (Cushman Coll. No. 5160.)

BULIMINA QUADRATA Plummer (Pl. 15, figs. 12-16)

Bulimina quadrata PLUMMER, Bull. 2644, Univ. Texas, 1927, p. 72, pl. 4, figs. 4, 5.

Bulimina pupoides CARSEY (not D'ORBIGNY), Bull. 2612, Univ. Texas, 1926, p. 29, pl. 4, fig. 3.—PLUMMER, Bull. 3101, Univ. Texas, 1931, p. 180, pl. 9, fig. 15.—SANDIDGE, Journ. Pal., vol. 6, 1932, p. 280, pl. 43, fig. 1.

Bulimina obtusa CUSHMAN (not D'ORBIGNY), Bull. 41, Tenn. Geol. Survey, 1931, p. 47, pl. 7, figs. 17, 18; Journ. Pal., vol. 5, 1931, p. 309, pl. 35, figs. 15 a, b.

13 x 14 = B
Hekapucensis
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Cushman
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We have many specimens which seem to be referable to this species. They all show some variation from Mrs. Plummer's species, but a careful study should be made with a much larger number of specimens than we have at our disposal before definite varietal forms may be set up. Our specimens fall roughly into four groups: 1, a large, broad type from the *Bulimina* zone of the Navarro (Pl. 15, fig. 12), a form somewhat shorter and broader than the typical and with more inflated chambers, but showing the typical angled joining of the chambers and the typical aperture with the plate-like tooth, some of the chambers being sufficiently transparent to show the inner tube; 2, a small form, found in the Arkadelphia and the Navarro (sometimes occurring with group 1) (Pl. 15, fig. 15), showing the typical joining of the chambers and the same aperture with the plate-like tooth, but smaller and with more inflated chambers, and with the wall of the lower half of the test roughened with minute spines, the perforations of the test being in many cases arranged in more or less regular longitudinal lines; 3, a form found in the Taylor in large numbers (Pl. 15, figs. 13, 14), resembling the typical rather more closely than the other groups but having more inflated chambers; 4, a form occurring in the Taylor in many cases with group 3 (Pl. 15, fig. 16), but smaller in size and showing the regular perforations seen in group 2, the lower part of the test somewhat roughened with minute spines, and terminated with one and sometimes two short spines.

None of these forms may be ascribed to *Bulimina obtusa*, as a study of topotype material has shown this to be a *Buliminella*. They are very similar to *Bulimina pupoides* d'Orbigny, but differ from it in the shape of the chambers, those of *Bulimina pupoides* lacking the angled character, in the very much less inflation of the chambers which are almost overlapping in *Bulimina pupoides*, and in the shape of the test which tapers less and has a more blunt initial end. Group 4 resembles d'Orbigny's species the most closely, but a comparison of groups of the two forms shows that they differ not only in the above characters but also in the range of variation shown by the two species.

